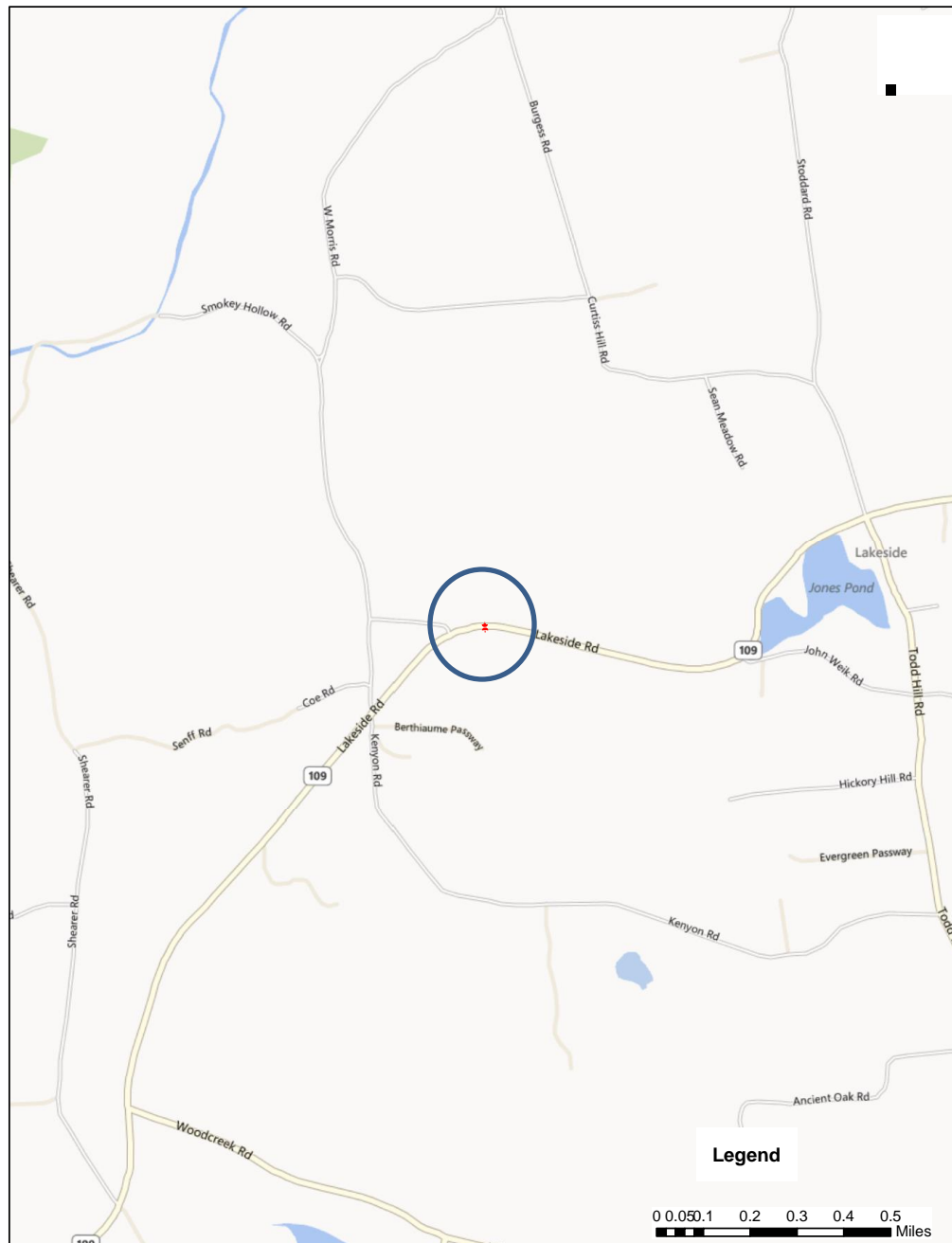


Br. No. 05417 Route 109 over Unnamed Brook, Morris

Structure Overview

Bridge No. 05417 carries Route 109 over Unnamed Brook in the Town of Morris. The structure was constructed in 1956. The approximately 58 year old structure consists of a metal arch culvert. Bridge No. 05417 provides approximately 11.4-ft x 7.25-ft (w x h) hydraulic opening and is approximately 62 ft. long.



Condition Ratings

Bridge No. 05417 is inspected by the Department biennially and condition ratings are prepared in accordance with FHWA Report No. FHWA-PD-96-001, "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges," (FHWA 1995) and the Department's Bridge Inspection Manual, dated September 2001 (as revised). Some of the condition ratings more pertinent to the evaluation of this project are summarized below. These ratings are based on an inspection that was performed on November 21, 2011.

Condition Rating Category	Rating from Recent Bridge Inspection Report	Condition Observed in Field	Potential Impact of Increased Discharge	Probable Action Required by Increased Discharge
Substructure (Item 60)	N/A (Not applicable, Culvert)	Consistent with Bridge Inspection Report	Minor	Minor
Channel and Channel Protection (Item 61)	6 (Minor damage, debris restriction)	Consistent with Bridge Inspection Report	Minor	Minor-routine maintenance
Structure Evaluation (Item 67)	5 (Better Than Minimum Adequacy)	Consistent with Bridge Inspection Report	Minor	Minor-routine maintenance
Waterway Adequacy (Item 71)	6 (Equal to present minimum criteria)	Consistent with Bridge Inspection Report	Minor	Minor
Scour Critical Bridges (Item 113)	8 (Foundation stable condition)	Consistent with Bridge Inspection Report	Minor	Minor

Roadway

This portion of Route 109 is classified as a “Rural Major Collector” consisting of two lanes in the vicinity of the structure. The roadway width approaching the structure is approximately 36-feet and the 2009 ADT is 1,700. The posted speed limit for Route 109 in the vicinity of the structure is 35 mph.

The bridge database indicates a 2 mile long detour would be required to bypass Br. No. 05417 in the event of closure/failure and this section of Route 109 becomes impassible.

Flood History/Designation

Flood History

There is no documented flood history specific to this site; however, based on generalized mapping of major flood events in the State, the structure may have experienced a 100-year event in January 1949, 100-year event in August 1955 and a 50-year event in June 1984.

FEMA Flood Zone Designation

The structure is located within the FEMA Flood Hazard Zone A. Br. No. 05417 is the downstream limit of the FEMA Flood Hazard Zone.

Hydrology

Description

A 2.01 mi² (1287 acre) drainage area discharges to the structure. Aerial photos indicate the rural drainage area is a mix of undeveloped woodlands and pasture with a scattering of residential structures. USGS quadrangle mapping indicates the unnamed brook flows through some areas of pond or swampland. According to the USGS web-based StreamStats evaluation, wetlands make up 2.5% of the drainage area. Based on the size and land use found in the drainage area, the USGS web-based StreamStats program was used to estimate the peak discharges at Br. No. 05417. StreamStats utilizes three parameter regression equations developed for the State of Connecticut. The variables used in the equations are drainage area, 24-hour precipitation and mean basin elevation.

Methodology/Parameters

Methodology: USGS Regression Equations (StreamStats)

Drainage Area: 2.01 square miles

Mean Basin Elevation: 977.37-ft

The following precipitation data was used in the calculations:

Return Frequency (Year)	2	10	25	50	100	500
24 Hour Precipitation (inches)	3.3	4.7	5.7	6.6	7.7	**

** Precipitation not used in 500-yr. regression equation

Results

The following Peak Discharges were estimated:

Return Frequency (Year)	2	10	25	50	100	500**
Peak Discharge (cfs)	115	246	317	376	442	600

** 500-yr. discharge estimated by Straight Line Log-Probability plot interpolation

Due to the greater than 1 square mile drainage area, Br. No. 05417 is classified as an “Intermediate Structure” per the Drainage Manual criteria. Intermediate structures are designed to pass a 100-year frequency discharge. To demonstrate the sensitivity of the design discharge calculation to increases in the precipitation parameter, the current 24 hour, 100-year precipitation was increased in ½ inch increments, up to a 4 inch increase, and the peak discharges associated with the increased precipitation were calculated. The results are presented in the following table:

Peak Discharge Resulting From Increase in Precipitation									
Precipitation Increase (inches)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Precipitation Increase (%)	0	6.5	13.0	19.5	26.0	32.5	39.0	45.5	51.9
100-yr Discharge (cfs)	442	490	540	591	644	699	756	814	874
Increase in Discharge (cfs)	0	48	98	149	202	257	314	372	432
Increase in Discharge (%)	0	10.9	22.2	33.7	45.7	58.1	71.0	84.2	97.7

A plot (rating curve) of the “Increase in 100-Yr Precipitation Vs. Increase in 100-Yr Peak Discharge” is included in the attachments following the narrative.

Hydraulics

Methodology

The FHWA’s Culvert Analysis Program HY-8 was used to evaluate the hydraulic adequacy and to develop rating (performance) curves showing the hydraulic performance of the structure over a range of flow conditions. Elevations in the analysis are based on an assumed datum with the Route 109 roadway elevation set at 100.0-ft. Based on the assumed datum, the inlet invert

elevation is approximately 89.75-ft. Freeboard is measured from the Route 109 roadway elevation to the headwater elevation.

Design Criteria

As previously indicated, Br. No. 05417 is classified as an “Intermediate Structure” per the Drainage Manual criteria. Intermediate structures are designed to pass a 100-year frequency discharge (Design Frequency) and the effects of a discharge equal to the 500-year flood (Check Frequency) passing through the structure are investigated. A minimum freeboard of one foot is required for the design frequency.

Results

Rating curves for the structure were developed showing Headwater Depth versus Peak Discharge and Outlet Velocity versus Peak Discharge. The rating curves are included in the attachments following the narrative. In addition, the results of the hydraulic evaluation are presented in the following comparison table:

Peak Discharge Description	Peak Discharge (cfs)	Headwater Elevation* (ft)	Headwater Depth (ft.)	Freeboard (ft.)	Pressure Flow Condition	Outlet Velocity (fps)
100-Year “Design” Discharge	442	97.23	7.48	2.77	no	10.39
500-Year “Check” Discharge	600	99.12	9.37	0.88	no	12.78
Inlet Submerged Begins	420	97	7.25	3	no	10
@ 1-Ft Freeboard	585	99	9.25	1.00	no	12.5
Overtopping Begins	668	100	10.25	0	no	13.46
*Based on assumed datum – Roadway = Elev. 100-ft.						

The hydraulic evaluation indicates that the structure can convey the estimated 100-yr frequency design event flows, based on current precipitation data, with freeboard meeting the design requirement. During the check storm event the structure does not have one foot of freeboard before reaching overtopping condition. The inlet begins to submerge at a discharge of approximately 420cfs.

Outlet velocities associated with the 100-yr frequency design event flows and the 500-year check storm events vary from approximately 10.39-ft/s to 12.78-ft/s, which are considered in the normal range. Bridge Inspection Reports indicate there is no notable streambed movement found.

Adaptive Capacity

As a part of the assessment of the adaptive capacity of the subject structure and the current hydraulic design criteria, the degree to which increases in the design precipitation could change

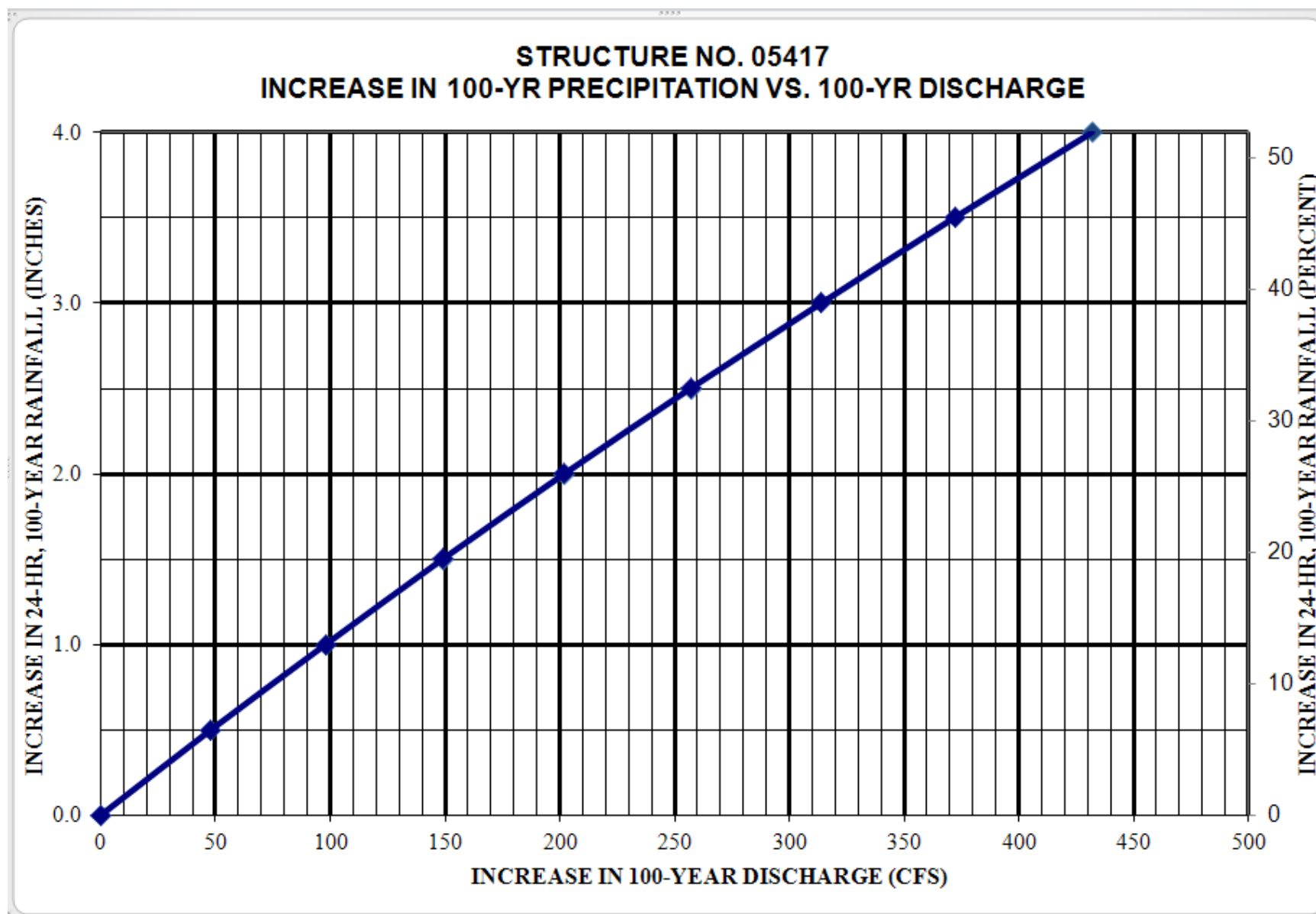
the design discharge was examined in relation to “key points” in the hydraulic performance of the structure. The following results are noted:

- An approximate 1.6 inch or 21% increase in the design (100-year) precipitation would increase the current 100-year design discharge of 442 cfs to 600 cfs, equivalent to the current 500-year discharge.
- The discharge at which the inlet begins to submerge is less than the 100-year design discharge.
- An approximate 1.4 inch or 18% increase in the design (100-year) precipitation would increase the current 100-year design discharge of 442 cfs to 585 cfs, equivalent to the discharge with 1-ft of freeboard.
- An increase in the design (100-year) precipitation in excess of 2.2 inches or 30% would be required to change the current 100-year design discharge of 442 cfs to the discharge where overtopping begins.

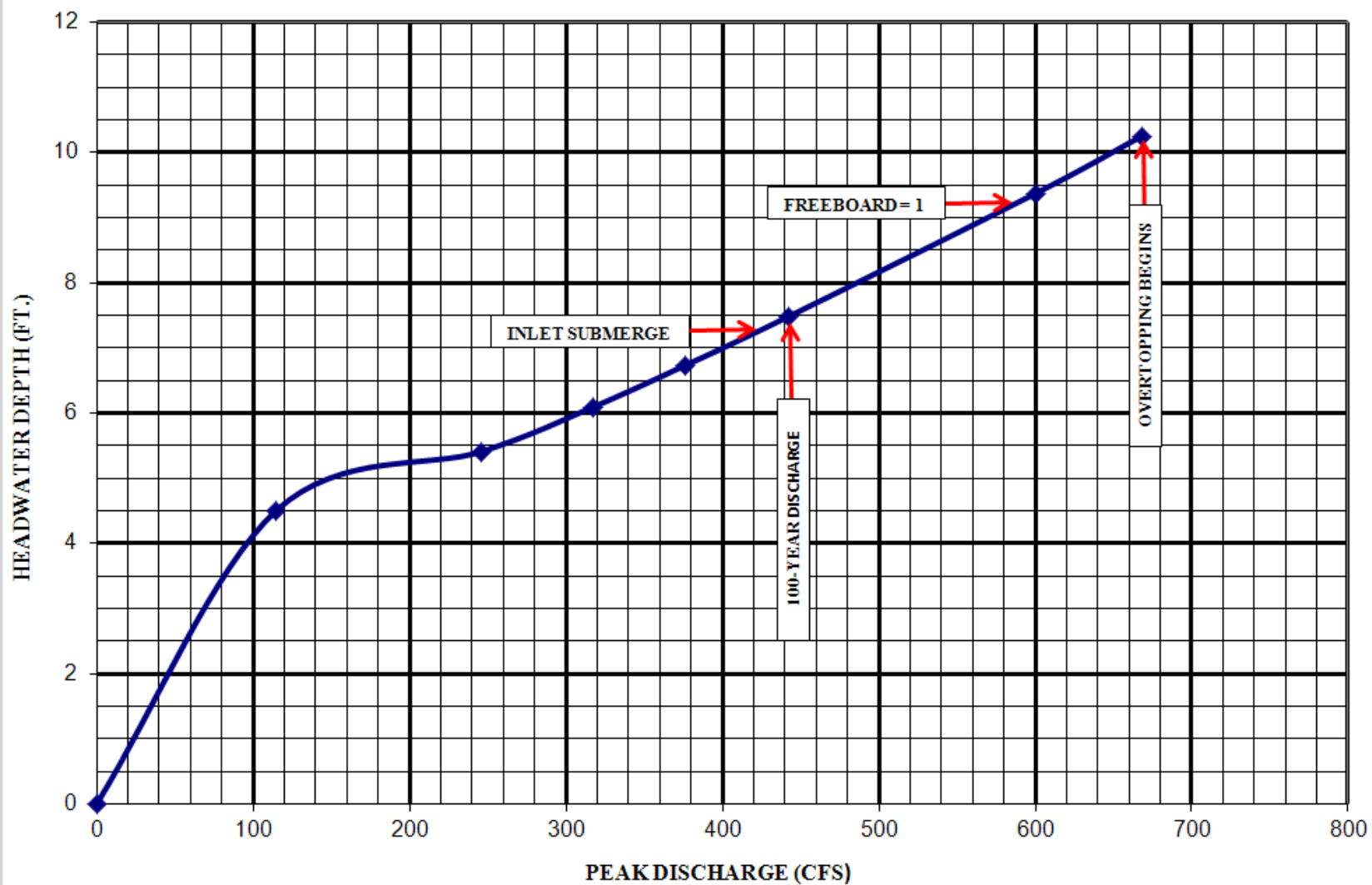
In regard to water surface elevation design criteria, the results of the hydraulic evaluation indicate that the structure just has the hydraulic capacity to convey flows at the design storm event with one foot of freeboard. The structure does not have the freeboard requirement for the check storm discharge. The structure has some adaptive capacity. The outlet velocity which is in the range of 12.5-ft/s to 13.5-ft/s when 1-ft of freeboard is available to when overtopping would begin. These velocities are in the normal range and the structure does not appear to be susceptible to scour or erosion.

Conclusion

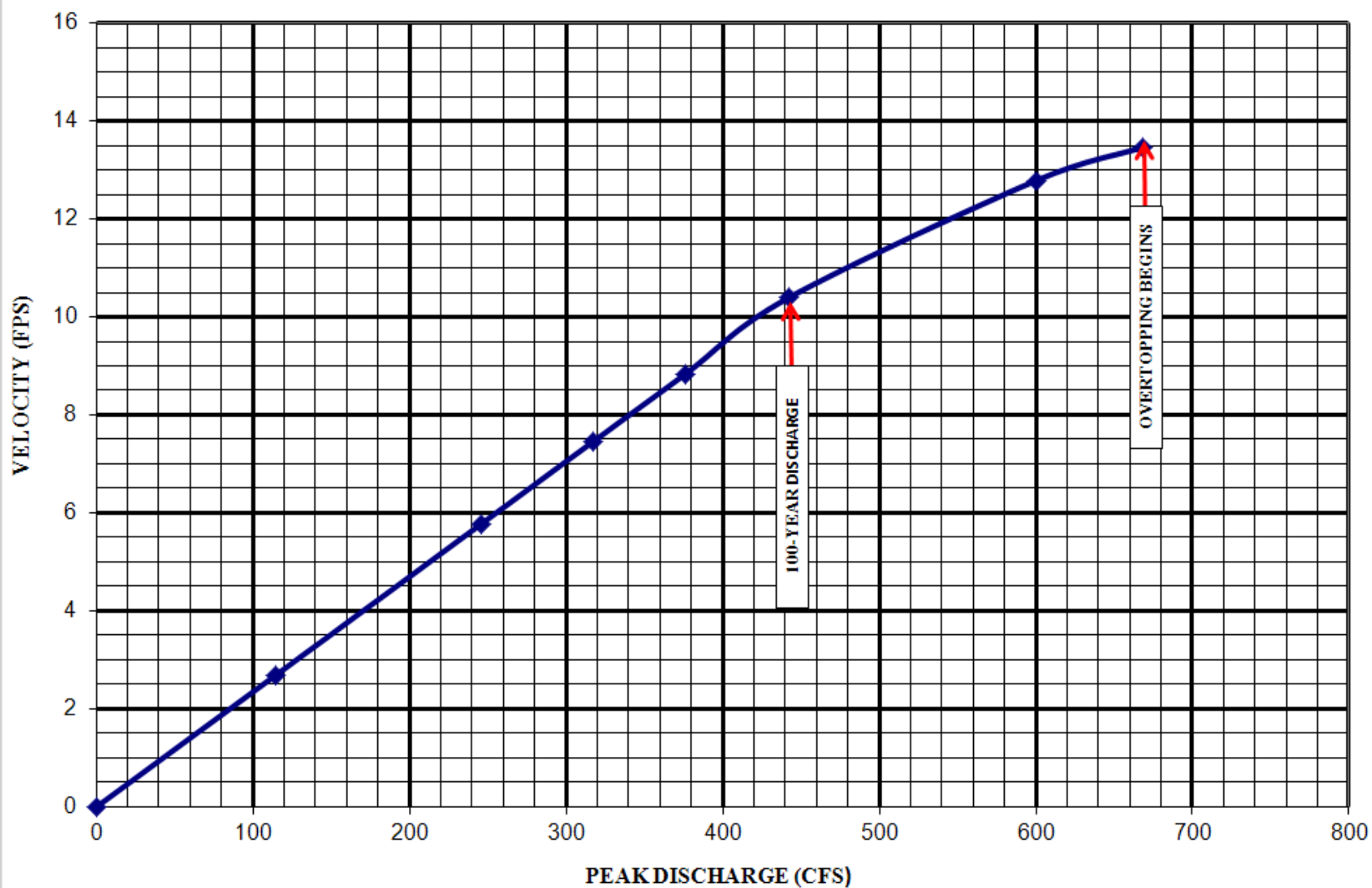
Br. No. 05417 is hydraulically adequate. The structure has the hydraulic capacity to convey the current 100-yr design discharge with one foot of freeboard and the 500-year check discharge without one foot of freeboard. The structure has some adaptive capacity. The outlet velocity is in the normal range and does not appear detrimental to the surrounding areas.



STRUCTURE NO. 05417
HEADWATER DEPTH VS. PEAK DISCHARGE



STRUCTURE NO. 05417
VELOCITY VS. PEAK DISCHARGE





Bridge No.	05417	Site Review by:	MFK
Town:	Morris	Site Review by:	PMM
Feature Carried:	Route 109	Date of Review:	7-12-13
Feature Crossed:	Unnamed Brook	Project No.:	170-0374



Photo # 1: Structure Inlet



Photo # 2: Upstream Channel

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Photo # 3: Structure Outlet



Photo # 4: Downstream Channel

Bridge No.	05417	Site Review by:	MFK
Town:	Morris	Site Review by:	PMM
Feature Carried:	Route 109	Date of Review:	7-12-13
Feature Crossed:	Unnamed Brook	Project No.:	170-0374



Photo # 5: Roadway Looking *West*



Photo # 6: : Roadway Looking *East*



Aerial View of Structure - Connecticut 2004 Orthophotography ("leaf off") & 2000 Contours (LiDAR)

